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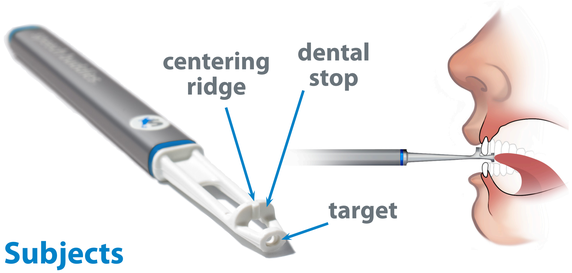
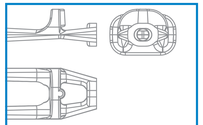
Evaluating the Efficacy of Treating Misarticulated /s/ with Tactile Biofeedback

ABSTRACT

This randomized, controlled, single-blind study examined the efficacy of the Speech Buddy® /s/ tool which uses the method of tactile biofeedback to teach correct tongue placement. Twenty school-aged subjects were randomly assigned to an experimental group or a control group and treated with eight individual therapy sessions. The experimental group, which used tactile biofeedback, recorded a statistically significant remediation response ($p < .05$), whereas the control group, which used only traditional phonetic-based treatment, did not show a statistically significant treatment benefit. These results suggest that tactile biofeedback enabled more efficient and consistent gains across the treatment period.





- Device can be held by a clinician, parent, or subject
- Precise intra-oral target placement achieved with the dental stop and centering ridge
- Design enables running speech and high speed airflow without sound distortion

Subjects

Twenty (20) subjects were enrolled in the research study, and were randomly assigned to the control or experimental group. Enrollment was based on the following criteria:

- Ages 5:0 to 8:11 years at the time of assent and parental permission.
- Incorrect production of the /s/ phoneme (i.e. 0-20% correct) according to a proprietary picture naming test that contained fifty (50) items.
- Hearing function within normal limits
- Age-appropriate receptive and expressive language skills (CELF-4 Screening Test)
- Native speakers of American English
- Have received less than ten (10) hours of therapy time for a speech sound disorder, as per parent reports.

Methods

This was a randomized controlled, single blind study to test the efficacy of an intra-oral tactile biofeedback device for the /s/ sound, the S Speech Buddy® (Articulate Technologies, Inc.). The test article taught correct tongue and jaw placement for the /s/ sound. The figures above highlight key features of the test article and how it can be used as a therapy aid in combination with simple verbal cues.

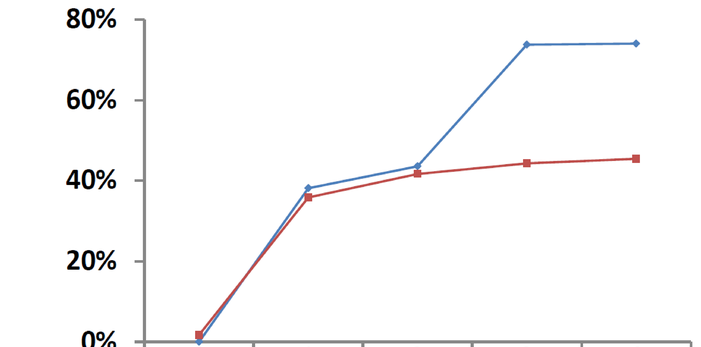
Treatment Session Structure:

- Eight sessions of approximately twenty five (25) minutes over a four to seven week period
- Forty-five (45) stimulus items (5 auditory discrimination, 6 isolation/syllables, 34 in words)
- Items chosen to represent a wide range of vocalic and consonantal contexts
- The number of items trained was consistent for both test groups

Control Group:

Traditional phonetic-based treatment sessions began with phonetic placement techniques that described correct placement and was followed by a clinician producing the model of the target sound in isolation.[1] In addition, verbal cues, visual cues and auditory bombardment were used during the sessions. Table 1 summarizes a sample treatment session.

Mean Percentage Accuracy vs. Timepoint



	0 (baseline)	1 (interim 1)	2 (interim 2)	3 (interim 3)	4 (final)
Experimental	0%	38%	44%	74%	74%
Control	2%	36%	42%	44%	45%

Methods (cont.)

Experimental Group:

Treatment sessions for the experimental group used the same phonetic-based techniques but practice was done with the Speech Buddy /s/ in oral placement, from isolation through the word level. With the device in place, oral placement remained consistent across practice training trials, with the primary cuing mechanism being tactile cuing.

Assessments:

All data were collected by a single, ASHA-certified, licensed, Ph.D.-level evaluator who was blind as to the subject's inclusion in either the experimental or control group. The blinded evaluator made judgments of correct versus incorrect for each test item. Inter-rater and intra-rater reliability tests were performed to test the accuracy and consistency of the evaluator. The assessments used were picture-naming tests consisting of words containing /s/ in various word positions and phonetic contexts. The same 50-word picture-naming test was used for the baseline assessment (the pre-treatment measure) and the final assessment (post-treatment measure). Three separate interim assessments, administered after sessions two, four, and six, consisted of three separate 20-word tests of randomly selected words from a set of 60 words. To mitigate a learning effect, no assessment items were used as treatment items.

Of the twenty subjects enrolled in the intent-to-treat population, fifteen subjects were included in the per-protocol analysis due to the following reasons: loss to follow up, loss of upper front dentition during the study, concurrent therapy disclosed post randomization. Table 2 summarizes participant characteristics.

Results

By the end of treatment, the mean change in accuracy of producing /s/ in the experimental group exceeded that of the control group. The figure above shows the average mean percent accuracy over time for both the experimental and control groups. The experimental

Table 1:
Sample Treatment Session

Number	Cue/Category	Word Position	Control Subject	Experimental Subject
Auditory Discrimination				
1	sip - tip	n/a	N	N
2	thin - sin	n/a	N	N
3	sack - Zack	n/a	N	N
4	walrus - walrush	n/a	N	N
5	fuzzy – futhy	n/a	N	N
Warm Up				
6	S (isolation)	isolation	N	Y
7	S (isolation)	isolation	N	Y
8	suh	initial syllables	N	Y
9	suh	initial syllables	N	Y
10	us	final syllables	N	Y
11	us	final syllables	N	Y
Therapy				
12	south	initial	N	Y
13	saga	initial	N	N
14	cinnamon	initial	N	Y
15	self	initial	N	N
16	syrup	initial	N	Y
17	sickle	initial	N	N
18	sand	initial	N	Y
19	sat	initial	N	N
20	sap	initial	N	Y
21	city	initial	N	N
22	safe	initial	N	Y
23	soil	initial	N	N
24	silver	initial	N	Y
25	simple	initial	N	N
26	city	initial	N	Y
27	said	initial	N	N
28	fossil	medial	N	Y
29	lesson	medial	N	N
30	juicy	medial	N	Y
31	recipe	medial	N	N
32	sevastle	medial	N	Y
33	princess	final	N	N
34	grace	final	N	Y
35	chase	final	N	N
36	loss	final	N	Y
37	mass	final	N	N
38	grass	final	N	Y
39	grease	final	N	N
40	class	final	N	Y
41	across	final	N	N
42	hiss	final	N	Y
43	chase	final	N	N
44	brace	final	N	Y
45	axe	final	N	N

N= No test article
Y= With test article

Table 2:
Participant Characteristics

Variables	Control Group			Experimental Group			Analysis		
Demographic	N	Mean	SD	N	Mean	SD	t	Df	p
Age (Months)	7	89.4	18.2	8	76.6	10.1	1.7	13	0.11
CELF-4 Screening Test[a]	7	9.0	2.9	8	7.0	3.1	1.3	13	0.22
Baseline characteristics	N	Mean	SD	N	Mean	SD	t	Df	p
Baseline accuracy (%)	7	1.7	4.5	8	0	0	1.07	13	.30
Treatment characteristics	N	Mean	SD	N	Mean	SD	t or U	Df	p
Time between first and last therapy session (Days)	7	37.6	9.9	8	32.5	8.5	1.1	13	0.30

Two-tailed
[a]Number above criterion score.

Table 3:
Response profile using Van Riper's 70-80% accuracy threshold.[1]

	Response	No Response
Experimental Group	87.5%	12.5%
Control Group	42.8%	57.1%

Results (cont.)

group, which used tactile biofeedback, recorded a statistically significant remediation response ($p < .05$), whereas the control group, which used only traditional phonetic-based treatment, did not show a statistically significant treatment benefit.

A one-way repeated-measures ANCOVA was conducted using SAS software version 9.2 to compare the effect of Speech Buddy use on performance over time. Performance at time 0 was the covariate. There was a significant interaction between time and group, ($F(3,35)=5.46$, $p=.004$).

In addition, as shown in Table 3, 88% of experimental group subjects responded to the intervention vs. 43% for the control group according Van Riper's 70-80% accuracy threshold for remediation.[1]

Discussion

This is a preliminary study designed to examine the efficacy of an intra-oral tactile biofeedback device in treating /s/. The results suggest that the device enabled more efficient, consistent and continued gains across the treatment period.

The data also suggest that intra-oral tactile biofeedback delivers a more reliable remediation response than does the traditional approach to treating speech sound disorders, which supports to the notion that SLPs should deploy multimodal cuing from the start of therapy.

The results obtained in the study also correlate to efficacy data found in investigations into other biofeedback technologies in speech sound treatment.[2,3,4,5,6] However, the test article provided the clinical benefit at a fraction of the cost and with minimal training. Additional studies should be performed to determine the benefit to populations with hearing impairment, post surgical cleft palate, childhood and acquired apraxia of speech.

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